MDE Product Development Team
FY14 November Monthly Report
Submitted 15 December 2013

With contributions from **Geoff DiMego** and **Mary Hart** (NCEP/EMC);
Stan Benjamin, John Brown, Steve Weygandt and **Curtis Alexander** (NOAA/ESRL/GSD);
Jordan Powers (NCAR/MMM); **Roy Rasmussen and Greg Thompson** (NCAR/RAL);
and **Ming Xue** (CAPS).

(Compiled and edited by S. Benjamin and B. Johnson)

Executive Summary

Task 1: Improve turbulence guidance from NWP forecasts

- RAPv2 continued in parallel testing on WCOSS by NCEP/EMC and also by NCEP/NCO through November, and December.
- RAP/HRRR presentation made by GSD to annual NCEP Model Production Suite Review, available at **http://ruc.noaa.gov/pdf/NCEP_PSR_2013_RAP_FINAL_v5.pdf**
- An important terrain elevation revision at the lateral boundary (Greenland and S. America) was developed and installed in RAPv2 in early November, not changing overall results but improving RAP robustness.
- A correction to radar reflectivity flags for RAPv2 was made to distinguish between no-echo and no-data.
- RAPv2 implementation at NCEP replacing RAPv1 is now scheduled for 29 January 2014.
- RAPv2 version run by ESRL was updated with the same terrain fix and continues to run smoothly on Jet (Boulder, RAP primary cycle) and Zeus (Fairmont WV) supercomputers and initializing experimental HRRR.
- Three real-time parallel RAP cycles (with extensive verification of each toward RAP version 3) running on Zeus NOAA research supercomputer located in Fairmont, WV to evaluate further likely enhancements to RAP data assimilation / model system for spring 2014 code freeze.
- NCEP making continued progress on NAM and NAM-nest

Task 2: Improve Quality of Convective Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

- Continued work to test and evaluate HRRR run infrastructure on NCEP WCOSS machine with NCEP implementation tentatively scheduled for Q3 FY14, following the RAPv2 implementation planned for 29 Jan 2014.
- Testing of WRF v3.5.1 with new shallow cumulus and an updated MYNN PBL scheme and updated versions of the Grell-3D and Grell-Freitas cumulus scheme in RAP real-time parallel runs
- Hourly and 15-min RTMA surface analyses running in real-time

Task 3: Improve Quality of Icing Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

- RAPv2 updated physics configuration now running in both RAPv2 at GSD and in parallel cycle on WCOSS machine at NCEP [MYNN boundary-layer scheme (Olson version), 9-level PBL, updated Thompson microphysics, others]
- Changes to various aspects of the MYNN surface layer and PBL schemes, as well as upgraded Grell-Freitas deep and shallow convection scheme now in parallel testing in RAP-dev2 version at GSD, with implementation of bona fide improvements expected in RAPv3 (in ESRL in Mar 2014 and at NCEP in winter 14-15)

Task 4: Develop convection-ATM-specific improvements to guidance from the HRRR (and later, HRRRE) and interact with CoSPA (or other) program partner labs and the FAA

- Real-time, frozen RAPv2/HRRR system continues to run successfully with gridded field dissemination into winter 2013-14 although CoSPA officially shut down on 1 Nov 2013.
- HRRR “failover” capability to use feed from Zeus instead of Jet during Jet downtime continued to work.

Task 1: Improve turbulence guidance from NWP forecasts

Improving turbulence forecast quality involves efforts to improve initial conditions for the RAP and NAM (and HRRR and NAM Nest models) and to improve the models (WRF-Advanced Research WRF (ARW)-RAP and NOAA Environmental Modeling System (NEMS)- Nonhydrostatic Multi-scale Model – B (NMMB)).

Tasks will include:

- Continuing evaluation of RAPv2 toward early 2014 implementation at NCEP, incorporating changes developed in 2012 and early 2013
- Development of RAPv3 toward 2014 implementation at ESRL and subsequent implementation at NCEP
- Collaborating on developing and testing best approaches for use of hybrid/EnKF/3DVAR data assimilation within common GSI coding structure.

ESRL

Regarding the operational NCEP RAP

The operational RAP (RAPv1) ran without any technical problems, including in the post processing, during November.

Progress toward RAPv2 implementation at NCEP
After good progress during October, the 30-day field test for the RAPv2 began at 12z 5 November. However, two issues cropped up during mid-November that were solved, but not without some considerable effort by folks at GSD and EMC (Geoff Manikin). The resulting delays have pushed back the date for implementation of RAPv2 to 29 January 2014.

The first of these issues was terrain-related. On 10 November there were two crashes of the NCO parallel RAPv2. Through the diligence and perseverance of Ming Hu, Curtis Alexander, Stan Benjamin and others at GSD working with Geoff Manikin at EMC during the last half of the holiday weekend, the crashes were traced to issues along the southern boundary where it intercepts steep terrain with numerous isolated peaks in Costa Rica, Venezuela, and Colombia. Fortunately, the primary RAPv2 cycle at GSD, running the exact same code on Zeus, also crashed, facilitating diagnosis of the cause of the crash and of candidate remedies. A solution was designed to avoid any north-south terrain gradient at the southern boundary to simply set terrain elevation at the outer row equal to the neighboring row one grid-point one in. These crashes were completely solved with this terrain elevation change.

A few days later a similar crash occurred near the northern boundary of the RAP over Gunnbjern, the highest point in Greenland. This was attributed to a large-amplitude mountain wave related to a strong cyclone over the Denmark Strait, and was a consequence of our decision of three years ago to not smooth the terrain in the RAP in order to produce more accurate wintertime 2-m temperature forecasts in valleys over inland Alaska. We have inserted a smoother terrain field over Greenland only and with the same north-south terrain gradient fix, and reruns of the crash case ran to completion. Terrain over North America is unchanged.

The second issue was a discovery that flags for 3-d radar reflectivity data for no-data and with-data-but-no-echo were set differently by radar processing at NCEP than at ESRL/NSSL, resulting in a deficit in snow cover in the NCEP RAPv2 over southern Canada. This problem was fixed on 3 Dec and updated snowfields were moved into the NCEP RAPv2 from the ESRL RAPv2.

The RAP web page **http://rapidrefresh.noaa.gov** was updated with latest information on the planned RAPv2 implementation. A link to the RAPv2 Technical Implementation Notice was added there also. A webpage on RAP output grids from NCEP was updated at **http://ruc.noaa.gov/rr/RAP-NCEP-output-grids.html**.

RAPv3 model testing

- With the release of WRFv3.5.1 by NCAR on 23 September, Tanya Smirnova began work toward merging the unique RAP features at the top of the WRFv3.4.1 trunk to v3.5.1. This went fairly smoothly, and the RAP-dev2 and dev3 on Zeus have been running with this version since 21 October.
- Revision and evaluation of the Grell-Freitas and more recent version of the Grell-3D convective scheme and their related shallow convection scheme continue (see Task 3).

- In mid-October the Grell-Freitas scheme was introduced into RAP-dev2 and WRFv3.5.1 into dev3, whilst RAP-dev1 continued to run RAPv2. This allows us to compare WRFv3.4.1 and 3.5.1 (dev1 and dev3) and the G-F scheme with the old WRFv3.2.1 G3 deep convection scheme (dev2 and dev3).
- Tanya Smirnova continues to investigate changes to the RUC LSM relating to surface roughness length over snow (see Task 3).
- New precipitation-type verification is being tested with retrospective and real-time RAP and HRRR output. Also, an NCEP w3lib routine was adapted to correctly transform RAP horizontal native grid output to the Alaska Grid 242 (Polar Stereographic) for verification purposes.

Other activities, some noted more fully under other tasks, also were undertaken:

- Retrospective testing for both RAP and HRRR of the impacts of proprietary in situ tower wind data and other special data under funding from the DOE Wind Forecast Improvement Project was concluded and a report is being written for DOE.
- Discussions with EMC continue concerning the best procedure to ensure that proprietary wind tower and nacelle wind measurements are available to the operational RAP and NAM now that WCOSS has come online.
- Biweekly telecons between GSD and the Storm Prediction Center of NCEP continue to be very beneficial. The purpose of these telecons is to obtain feedback from SPC on RAP (RAPv2 from GSD as well as the operational v1) and GSD HRRR-primary performance, to give SPC opportunity to comment on our ongoing RAP and HRRR development work, and to inform SPC of planned Jet and Zeus computer downtimes.
- On 18 November representatives from General Dynamics, ESRL and NCAR/RAL met to discuss a report on probabilistic (convective) weather forecasting and related air traffic management decision-making prepared by General Dynamics.
- Stan Benjamin, Steve Weygandt, Curtis Alexander, Ming Hu and Haidao Lin attended the annual NCEP Product Suite Review held at NCEP on 5-8 December. Steve, Curtis, and Stan made a presentation on the RAP, HRRR and FIM. This presentation is available at **http://ruc.noaa.gov/pdf/NCEP_PSR_2013_RAP_FINAL_v5.pdf**
- This NCEP visit provided opportunity for productive face-to-face discussions with NCEP scientists on a variety of topics, including EnKF hybrid data assimilation and NCEP access to the MRMS (multiple radar multiple sensor) products produced by the NOAA National Severe Storms Lab.

NCEP

The parallel testing of the Rapid Refresh at NCO suffered a setback in November with several crashes related to topography. The first set of failures occurred with strong winds over very sharp terrain along the southern boundary in Venezuela. The second set of crashes occurred with winds over Greenland at a point near the northern boundary with extremely steep topography. The fixes were to set the surface height of the boundary outer rows equal to the point one row in and then to revise the topography over Greenland by applying a smoother. The 30-day evaluation period for the parallel restarted on Thurs 5 December. (Geoff Manikin)

A new project was started that will eventually impact large parts of the GSI code, with the goal of making GSI more scalable. Most users of GSI are now running into the problem that for high-resolution models or for very large domains or both, the code begins to use too many resources on current and future parallel machines. This is the case for the upcoming GFS T1534 implementation. The global analysis grid for the T1534 upgrade package is being kept at T574 to fit things in, and the ensemble-Kalman-Filter part is only being increased from T254 to T574. Ideally, these would be much closer to T1534. (Dave Parrish)

The RTMA/URMA [2D-var version of GSI] upgrade package has been presented to the EMC Configuration Control Board to get authority to start the 30-day pre-implementation testing. Due to the intermittent failures in RAPv2 in early Nov, EMC decided to de-couple the RTMA and RAPv2 parallels. Therefore, additional monitoring of the RTMA parallel was performed following the switch from RAP-V2 to RAP-V1 as the model first guess used over CONUS in both RTMA & URMA. Work on splitting the GSI control variables used for the RTMA into land and water components has been resumed. (Manuel Pondeca, Steve Levine, Yuqiu Zhu)

The SREF interim upgrade package was transitioned to the operational environment and a parallel began running daily in real time on Nov. 22. The scheduled implementation date for this upgrade is in Feb. 2014. (Jun Du) The NCEP Storm-Scale Ensemble Time-Lagged (NSSE-TL) website has been made to be more regularly updated than in the past – see **http://www.emc.ncep.noaa.gov/mmb/SREF_avia/FCST/NSSE/web_site/html/etop.html**. (Binbin Zhou)

The package for converting 3D reflectivity mosaic to grib format was upgraded to use grib2 format. The package is under parallel test. The parallel run for assimilating reflectivity (NAMREF) was upgraded to use the latest GSI, assimilation scripts, and version of the NMMB model. Efforts were also made to check a drop in the 60 hour precipitation ETS score in the NAMREF parallel. Cloud analysis changes (needed for using reflectivity in diabatic digital filter) are being integrated into the GSI trunk in coordination with ESRL/GSD's Ming Hu. (Shun Liu, Matt Pyle)

A new project began to add the capability for GSI to assimilate the wind speed and direction instead of U and V components. The motivation was to assimilate the quantity that is directly observed so that the observational error variance can be defined without contamination from the transforms. Scripts and fix files were prepared for the NDAS parallel using the new satellite channel bias correction. The GOES hourly wind data flow was checked so that we can start monitoring the hourly visible winds in NAM parallels. Information was provided to Eric Rogers so he can tune the GSI run time in his parallels [see **http://www.emc.ncep.noaa.gov/mmb/mmbpll/eric.html#TAB2**] in preparation for the upcoming NAM implementation. (Wan-Shu Wu)

CAPS

During November, CAPS worked on revising a Monthly Weather Review paper documenting the hybrid data assimilation testing results at the 40 km resolutions. Significance testing results had to be added for most of the comparison results.

Additional information on RAP-related tasks

ESRL

GSD continues to make pgrb and bgrb files from the ESRL/GSD RAP-primary (RAPv2) real-time 1-h cycle available from its FTP site for users in NWS and other labs**.**

NCEP

NCEP maintained real-time availability of SAV and AHP guidance to all vendors from the operational hourly RAP on pressure surfaces via the NWS Family of Services (FOS) data feed and via the FAA Bulk Weather Data Telecommunications Gateway (FBWDTG). (EMC and NCO)

NCEP maintained real-time availability of full resolution gridded data from the operational RAP runs via anonymous ftp access via the NCEP server site at **ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/rap/prod/** and at the NWS/OPS site at **ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/** in hourly directories named MT.rap_CY.00 through MT.rap_CY.23. This includes hourly BUFR soundings and output grids, which undergo no interpolation. Both sites now contain only grids in GRIB2 format **http://www.nco.ncep.noaa.gov/pmb/docs/GRIB1_to_GRIB2.shtml.** Gridded RAP and NARRE [-TL] fields are available on **NOMADS** for the CONUS domain on 13 km grid #130 and the Alaska domain on 11.25 km grid #242. RAP fields are also available for the larger North American domain on 32 km grid #221. A limited set of fields from the RAP runs (and other NCEP models) can also be viewed at **http://mag.ncep.noaa.gov** . (EMC&NCO)

Verification of RAP

ESRL's verification of the RAP is available from **http://ruc.noaa.gov/stats**. NCEP maintained its capability and provided access to routine verifications of the operational RAP analyses and forecasts. These include grid-to-station verifications versus rawinsonde, surface, aircraft, Profiler, and VAD data computed periodically at NCEP and accessible via NCEP's Mesoscale Modeling Branch website: **http://www.emc.ncep.noaa.gov/mmb/research/meso.verf.html** .

Deliverables	**Delivery Schedule**
Task 1 – Improve turbulence guidance from NWP forecasts	
a. Finalize code for RAPv2 for implementation at NCEP (ESRL, NCEP) • Vigorous effort leading complete package with extensive improvements, summary at:	Mar 2013 **COMPLETE**

Deliverables	Delivery Schedule
http://ruc.noaa.gov/pdf/ESRLRAPHRRRchanges2013.pdf	
b. Complete the testing of the 40/13 km dual-resolution hybrid DA system for RAP with 3-hourly cycles with conventional data (GSD, CAPS) • Initial work completed by CAPS, testing of further enhancements to system. GSD testing and inclusion in RAPv2 of hybrid system with full observational data, using GFS ensemble data. Milestones exceed.	Mar 2013 **COMPLETE**
d. Report on early version of RAPv3 primary cycle at GSD with physics enhancements for initialization of the HRRR. (ESRL) • Good progress with revised assimilation and WRFv3.5.1 as reported under Task 1. For more completeness, we request a delay to make this report by 30 January 2014.	**Delay to Jan 2014**
e. Report on the optimal configurations for including satellite data in the ensemble hybrid system to ensure overall positive impacts of the data (NCEP, ESRL)	Dec 2013
f. Finalize RAP version to initialize experimental HRRR for 2014 real-time use toward operational HRRR (ESRL)	Mar 2014
g. Deliver progress report on development of NARRE (NCEP, ESRL)	Mar 2014
h. Deliver progress report on ensemble/hybrid data assimilation for use in NARRE (ESRL, NCEP)	Mar 2014
i. Subject to NCEP Directors' approval, upgrades to observation processing and/or quality control and/or GSI and/or NMMB systems become Operational at NCEP. (NCEP)	Mar 2014
j. Incorporate physics and dynamics improvements from the user community, GSD, and NCEP into WRF for use in the Rapid Refresh system. (NCAR-MMM)	Mar 2014

Task 2: Improve Quality of Convective Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

GSD

In November, work began on initial testing of updates for the Mar 2013 internal freeze, which will serve as a prototype for a RAPv3 with a likely implementation at NCEP in 2015. The first task was updates to latest community trunk versions of the GSI hybrid analysis and the WRF ARW model (3.5.1). Work with the model has focused evaluation of the updated Grell-Freitas cumulus parameterization relative to the existing Grell-based scheme, with an expectation that some calibration of scheme parameters would be necessary. First retrospective results confirmed this expectation, indicating a decrease in the amount of precipitation for higher thresholds over land. Work with Georg Grell is continuing to refine scheme parameters to optimize the results.

Ming Hu has been testing the latest version of the GSI (from the EMC trunk repository) and initial results indicate the desired outcome of matched performance for a RAP application with matched input parameters. The new GSI formulation includes several upgrades that should be beneficial to the RAP, including improved satellite bias correction, and an updated community radiance transfer model (for the satellite radiance assimilation).

Several branch members travelled to NCEP for the Production Suite Review (meetings between model developers and model users – mostly NWS centers and regional offices), and held many meetings to discuss modeling and data assimilation issues with EMC model developers. The GSD presentation on RAP/HRRR made at this meeting is available at **http://ruc.noaa.gov/pdf/NCEP_PSR_2013_RAP_FINAL_v5.pdf**. From these discussions, AMB personnel learned of many new community developments that benefit the RAP (including the satellite enhancements noted above and option for adjusting the covariance localization parameters in the GSI hybrid analysis). There was shared discussion on a wide variety of other topics including NARRE/HRRE development, 15-min radar data feed for reflectivity (for HRRR implementation) and radial velocity (likely will be included in the HRRR v2 implementation).

Patrick Hofmann has continued work on an AMB version of the Real-Time Mesoscale Analysis (RTMA) using the HRRR as a background. He now has hourly and 15-min versions of this running in real-time and he has switched these from Zeus to Jet for greater run reliability. RTMA discussion at EMC focused on optimizing the name-list settings and on getting a 15-min feed of surface observations for the analysis.

Curtis Alexander continued his work of building the HRRR system on WCOSS and transitioning testing capability to Geoff Manikin. Curtis previously built a simple HRRR test system (no 3-km pre-forecast radar data assimilation) on WCOSS and Geoff Manikin was able to run it. This enabled system analysis personnel at NCEP to examine the run configuration to facilitate recommendations for optimizing runtime and computer usage for the HRRR model run. Curtis is continuing his work on the WCOSS HRRR, completing most of the building of the 3-km pre-forecast hour 15-min radar assimilation package. This work will enable Geoff Manikin to run the full HRRR system, so it can be evaluated and then be transferred over to NCO for operational implementation. This implementation is scheduled for Q3 of FY14.

NCEP

NCEP EMC and NCO conducted a planning exercise of what the modeling suite might look like on the Weather and Climate Operational Supercomputing System (WCOSS) Phase 1 (2013-2015) and Phase 2 (2015-2018). The size of the latter would be enhanced by the Sandy Supplemental funds. This plan incorporated ESRL/GSD along with all other contributors to the NCEP Production suite. NWS Director Louis Uccellini was briefed 28 March. While tentative, these plans called for an initial HRRR implementation on 65 nodes on Phase 1, and a HRRR Ensemble (HRRRE), combining multiple runs with configurations of both WRF-ARW and NMMB, on Phase 2. A sizable bank of computing (65 nodes) was dedicated on Phase 2 to advanced data assimilation for the convective allowing scales of the HRRRE, likely involving a 4-dimensional version of the current GSI-hybrid-EnKF.

Deliverables	**Delivery Schedule**
Task 2 – Improve Quality of Convective Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE	
a. Report on initial tests of 3-km 15-min RTMA cloud / surface analysis for use in frontal diagnostics, CI assessment and other near-surface assessments (ESRL, NCEP) • *Good progress toward 3km RTMA and RUA surface and cloud analyses* • *Successful initial tests summarized in report:* **http://ruc.noaa.gov/pdf/GSD_RTMA_report.pdf**	Feb 2013 **COMPLETE**
b. Incorporate all assimilation and model changes that affect the HRRR into a frozen version of HRRR (and parent Rapid Refresh) for 2013 real-time use (ESRL) • *Extensive set of enhancements in place and running in real-time experimental GSD RAPv2 / HRRR system*	Mar 2013 **COMPLETE**
c. Provide preliminary 15-min RTMA surface analyses as experimental improved basis for frontal diagnostics and other diagnostics from surface analyses (ESRL, NCEP)	Aug 2013 **COMPLETE**

Deliverables	Delivery Schedule
Prototype HRRR-based 15-min RTMA analysis completed with sample grids and graphics.	
d. Report on computing resource status on NCEP Central Computing System, NOAA R&D Site A and NOAA R&D Site B with regards to possible implementation of HRRR (NCEP, ESRL) See above discussion concerning ~2014 implementation and Task 4	**June 2013** **COMPLETE**
e. Complete FY13 internal assessment with revised 3-km HRRR running every hour (ESRL) **Assessment complete with very good results seen for 2013 HRRR in objective and subjective verification and high run reliability**	Sept 2013 **COMPLETE**
f. Provide revised 15-min RTMA surface analyses as primary basis for frontal diagnostics and other diagnostics from surface analyses for real-time use in 2014 (ESRL, NCEP). **Good progress with real-time running.**	Feb 2014
g. Finalize all changes to the HRRR for real-time use in 2014 (ESRL)	Mar 2014

Task 3: Improve Quality of Icing Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE

GSD

The RAPv2 physical parameterization configuration resulting from test and evaluation of physics options during the late 2012 – early 2013 period and described in previous reports is also what is being tested now on the NCEP WCOSS computer in preparation for the RAPv2 implementation scheduled for FY2013 Q2:

- New 9-level configuration of the RUC land-surface model (RUC LSM) with fix to canopy evaporation when the MYNN surface layer is used.
- Mellor-Yamada-Nakanishi-Niino (MYNN) planetary-boundary- and surface-layer scheme (modified considerably by Joe Olson) in place of the Mellor-Yamada-Janjic (MYJ) scheme used in RAPv1.
- Continue use of the Grell G3 scheme from WRFv3.2.1.
- Continue use of the Goddard short wave and RRTM long-wave radiation schemes.
- Use WRFv3.4.1 version of the Thompson microphysics.

Ongoing and anticipated efforts toward improving all aspects of the physics over the next several months will result in significant changes for RAPv3. The status of this work is summarized in what follows.

- Possible replacement of RRTM longwave and Goddard shortwave radiation by the long and short wave versions of RRTMG. In addition to provision for attenuation of solar radiation by aerosol, RRTMG has a more rigorous accounting for the attenuation of solar radiation by ice and snow recently developed by Greg Thompson. Consideration may also be given to better accounting for attenuation of solar radiation by boundary-layer-driven clouds through prediction of a cloud fraction (this work leveraged from other agency funding and in collaboration with NCAR). A consideration in the decision to use RRTMG may be additional computational cost.
- Further testing of candidate LSM and MYNN surface-layer changes. These include 1) treatment of albedo in situations of partial snow cover, which itself must be parameterized, 2) reduction of surface roughness in areas of snow cover over tundra, scrubland and cropland (earlier testing on this was mostly done with the MYJ PBL and surface layers; purpose is to reduce a cold bias in 2-m temperatures under very stable conditions), 3) further consideration of the representation of snow melt in low-level warm-advection conditions typical of spring. A combination of retrospective experimentation and real-time evaluation this winter is underway.

- Further upgrades to the MYNN surface and boundary layer schemes. A primary goal of this work is to reduce the daytime warm and dry bias we see with the MYNN scheme under clear skies, particularly during the warm season. Because this warm / dry bias is likely a result of the interplay between the land-surface scheme, the surface and boundary-layer scheme and the parameterized convection, MYNN modifications must be tested together with the deep and shallow convection parameterization. Joe Olson has introduced some minor changes to the MYNN that decrease entrainment into the daytime mixed layer from above as part of an effort to mitigate the daytime warm and dry bias in the warm season. More importantly, Joe and Georg Grell developed an improvement to the treatment of shallow cumulus clouds, which is intended to address this issue. Evaluation of these changes is underway using the May-June 2013 retrospective period.
- Possible replacement of the G3 convection scheme used in RAPv1 and RAPv2 by the Grell-Freitas deep and shallow scheme. In mid-October Georg Grell found a source of deficient precipitation from the parameterized convection in the G-F scheme that had been plaguing the scheme since it was first tested in RAP. With this fix in place in RAP-dev2 since 22 October, this cycle is now giving results generally competitive with RAP-dev3 also running WRFv3.5.1, but using the old v3.2.1 G3 scheme currently in RAPv1 and RAPv2. However, because convection over the CONUS has been scarce since late October (as expected this time of year), satisfactory performance of GF in a summer retro is a prerequisite for it to be used in RAPv3 in place of G3. So far this has not been achieved. Use of only the shallow portion of G-F will be considered for HRRR application.
- Testing of changes to the Thompson microphysics for WRFv3.5.1. We anticipate these will mainly impact higher rainfall rates and therefore may be of importance for the HRRR configuration in 2014. Evaluation in HRRR has not yet begun.
- New aerosol-aware microphysics from NCAR. Pending NCAR's preparing the code for transfer to GSD (see item a. under table of Task 3 deliverables below), test and evaluation will begin by GSD. This is a potential major change and will require careful evaluation. In preparation for this, GSD met with Greg Thompson of NCAR on 15 Nov to plan some details on this transfer. We anticipate significant testing of the aerosol-aware microphysics in 2014 toward implementation in the March 2015 ESRL versions of the RAP and HRRR.

NCEP

With the HRRR prediction model running fairly efficiently, NCEP is awaiting the remainder of the HRRR system containing initialization, post-processing and product generation components which must all fit into the allocated space and complete each run within an hour.

NCAR/RAL

CURRENT EFFORTS: In the month of November, NCAR-RAL worked jointly with WRF developers in MMM to transfer the new aerosol-aware Thompson & Eidhammer (2013) microphysics code changes into the WRF code repository. G. Thompson also visited with GSD developers of RAP/HRRR to discuss and plan the implementation and testing of the new scheme.

FUTURE EFFORTS: Once integrated into the WRF code repository, NCAR-RAL will assist NOAA-GSD to adopt/utilize the new scheme. NCAR-RAL and NOAA-GSD still need to plan and carry out a method to link aerosols/species found in WRF-RAP-Chem to simplify into those variables used by the new microphysics scheme; or, alternatively, use with built-in climatological aerosols.

PROBLEMS/ISSUES ENCOUNTERED: The integration of the aerosol-aware microphysics scheme depends on availability of NOAA-GSD and NCAR-MMM personnel and a timeline of activities has not yet been decided.

INTERFACE WITH OTHER ORGANIZATIONS: David Gill and Michael Duda, NCAR-MMM

NCAR/MMM

Deliver a WRF Users' Workshop and WRF Tutorial for the User Community

The next WRF tutorial organized by MMM will be at NCAR on January 22–31, 2014. In addition to the basic WRF tutorial, it will include a WRF/DART ensemble DA tutorial and a MET (Model Evaluation Tools) tutorial. Preparations for the 2014 WRF Users' Workshop will begin after the new year.

PLANNED EFFORTS: Tutorial scheduled for January 2014

UPDATES TO SCHEDULE: None

Incorporate Physics and Dynamics Improvements into WRF

NCAR is overseeing the preparation of the next major release, WRF V3.6. Regular meetings of the Release Committee were conducted and candidate codes have been contributed by the community. The release will be in Spring 2014, and details may be found at: **http://wrf-model.org/users/release.php**.

A new microphysics scheme for WRF is being prepared for the next release (V3.6). Jimy Dudhia (NCAR/MMM) obtained the Spectral Bin Microphysics (SBM) scheme from Barry Lynn and Alex Khain (Hebrew University of Jerusalem). Dudhia has done initial testing of the package in preparation for its addition to the WRF repository.

Dudhia worked with visitors Pedro Jimenez (CIEMAT, Spain) and Raquel Lorente (Univ. of Murcia, Spain) on improvement of WRF's topo_wind option for the diurnal cycle. They are currently choosing a method to reduce the topo_wind effect in daytime convective PBLs, where they found a low wind speed bias due to the option's enhanced frictional effect. The main challenge will be with the evening transition. There, heat fluxes drop, but convective mixing still occurs, and topo_wind's effects are not sought.

In radiation physics, Dudhia continued working with Jose Ruiz-Arias (Univ. of Jaen, Spain) to prepare WRF-Solar code for the V3.6 release. For this they are finalizing the aerosol input capability for the RRTMG and Goddard SW radiation schemes. This allows use of aerosol information to provide better total, direct, and diffuse solar fluxes at the surface. Dudhia and Ruiz-Arias are also working on a shortwave surface interpolation method yielding a smooth variation between time steps. The goal is to account for rapid cloud changes using a statistical fit to integrated liquid-water path as part of the interpolation. Initial results look promising.

Ming Chen (NCAR/MMM), Changhai Liu (NCAR/RAL), and visitor Feng Chen (Zhejiang Meteorological Bureau began work on evaluating the CLM LSM in WRF at 4-km grid size over complex terrain. Because the CLM scheme is costly, they have configured it to be called less often than at every model time step.

PLANNED EFFORTS: The development and incorporation of new physics and dynamics for WRF for the RAP and HRRR will continue through this quarter.

UPDATES TO SCHEDULE: None

Deliverables	**Delivery Schedule**
Task 3 – Improve Quality of Icing Weather Forecasts from RAP, HRRR, NAM, NAM-nests and, eventually, NARRE and HRRRE	**Delivery Schedule**
a. Conduct initial single test of aerosol-aware microphysics in ARW in a RAP configuration as start of a 2014 evaluation for its suitability as part of the RAPv3 prototype for 2015 NCEP implementation (NCAR-RAL, ESRL) • This task name has been changed to accurately reflect the long-term evaluation needed for this complicated change over much of 2014.	Feb 2014. Task name changed.
b. Final model physics code transfer complete to EMC for Rapid Refresh 2 upgrade change package to be implemented at NCEP by spring 2014 (ESRL, NCEP) • Freeze of model physics code for March 2013 version of RAP at ESRL allows this milestone to be met.	Mar 2013 **COMPLETE**

c. Pending NCEP computer readiness and EMC and NCEP Center initial recommendations, Requests for Change (RFCs) are filed to submit WRF physics code changes as part of upgrade for Rapid Refresh v2 software to NCO (NCEP, ESRL)	**Sept 2013** **COMPLETE**
d. Transfer upgraded coupled aerosol-microphysics scheme into a test version of HRRR (NCAR-MMM, ESRL)	Dec 2013
f. Finalize microphysics changes and other physics changes to improve icing forecasts for ESRL version of RAP and HRRR for 2014 real-time use (ESRL)	Mar 2014
g. Report summary of icing probability skill measures by quarter for the year. (NCEP)	Mar 2014

Task 4: Develop convection-ATM-specific improvements for guidance from the HRRR (and later, HRRRE) and interact with CoSPA (or other) program partner labs and the FAA

Task 4 – Complete implementation of new microphysics for associated reflectivity echo-top diagnostics for 2013 real-time use (ESRL)

Current:

A new retrospective period from 15-31 May 2013 has been established to begin evaluation of model and data assimilation changes for the 2014 version of the ESRL RAP and HRRR. A control run for the retrospective period has been completed using the 2013 ESRL RAP and HRRR versions but also include an adjustment in soil temperature and moisture and a correction in the RUC land surface model to remove unrealistic surface evaporation flux in areas of precipitation that were not available during the real-time runs in early May 2013. The code for the WRF-ARW version 3.5.1 update including changes to the Thompson microphysics scheme and associated reflectivity, VIL and echo top diagnostics has been merged with the ESRL RAP and HRRR WRF-ARW code base. An initial RAP retrospective run with WRF-ARW version 3.5.1 has been completed for the May 2013 period along with an upper-level and surface forecast verification comparison to the control run. This forecast verification has identified an additional change needed in the WRF version 3.5.1 RAP convective parameterization before another retrospective run can be executed.

Planned:
We plan to complete the transition to the new format radar reflectivity data feed for both the ESRL RAP and HRRR radar data assimilation.

Evaluation of additional ESRL RAP and HRRR model and data assimilation changes will be conduced using the 15-31 May 2013 retrospective period. Once the RAP changes are determined, HRRR retrospective runs will be executed including an evaluation of the latest Thompson microphysics scheme in WRF-ARW version 3.5.1 along with testing and calibration of the associated reflectivity, VIL and echo top diagnostics.

Task 4 – Assess HRRR reliability and provide monthly reporting (ESRL)

HRRR Reliability for 0-8 Hour VIL/Echo Tops for November 2013

Jet
All runs: 88.3%
3 or more consecutive missed runs: 97.4% (most meaningful for CoSPA)
6 or more consecutive missed runs: 98.9%
5 outages of at least 3 hrs. or longer
3 outages of at least 6 hrs. or longer

Zeus
All runs: 67.1%
3 or more consecutive missed runs: 75.0% (most meaningful for CoSPA)
6 or more consecutive missed runs: 81.9%
19 outages of at least 3 hrs. or longer
14 outages of at least 6 hrs. or longer

Combined (Jet or Zeus)
All runs: 95.8%
3 or more consecutive missed runs: 99.6% (most meaningful for CoSPA)
6 or more consecutive missed runs: 100.0%
2 outages of at least 3 hrs. or longer
0 outages of at least 6 hrs. or longer

Under Task 4 – Complete implementation of refined SatCast assimilation for HRRR for real-time use in 2014

Tracy Smith continued her work with the assimilation of GOES-CI cloud-top cooling radar data within the RAP. Following her initial experiments she has completed an additional retrospective experiment using a higher cooling rate threshold and successfully removed some of the false alarms (see Fig. 1 below), resulting in slight higher skill scores. Additional experiments are ongoing.

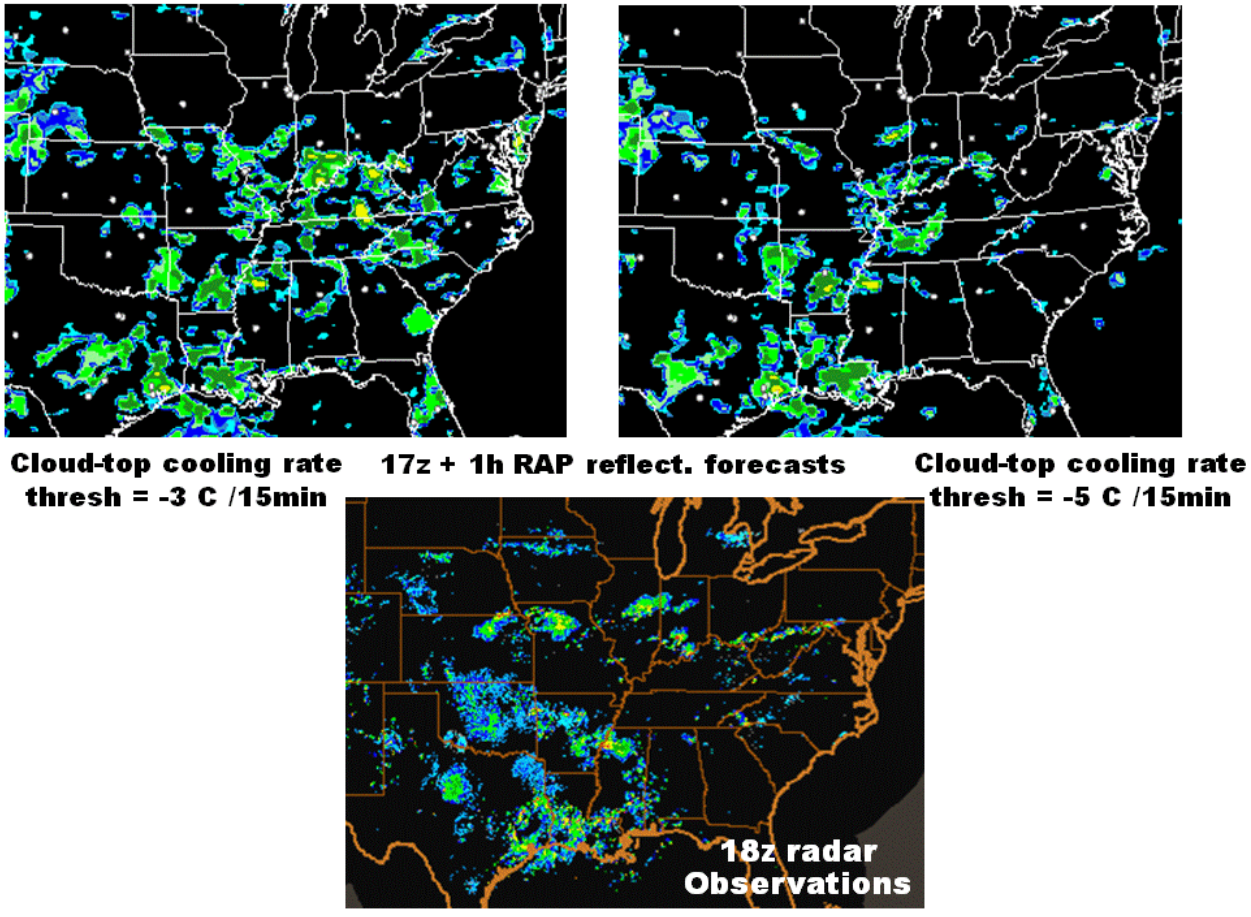

Fig. 1, Comparison of RAP 1-h forecasts valid 18z 8 July 2012 with assimilation of satellite-based cloud-top cooling rate data using a minimum threshold a -3 deg. C per 15 min. (left) and -5 deg. C per 15 min (right). Comparison with the radar observations (bottom) illustrates the reduction in spurious convection associated with the more restrictive -5 deg. threshold (right).

Also Under Task 4 – Interact with CoSPA (or other) program partner labs and the FAA

Team (ESRL/GSD, NCAR/RAL, and MIT/LL) telecons and e-mail correspondence have and will continue to occur during the CoSPA offseason regarding upcoming HRRR changes. Discussion with MIT/LL continues regarding possible collaboration on convective weather avoidance polygons including the potential for feedback on the evolution of the size distribution of forecasted convective structures in the HRRR.

Deliverables	Delivery Schedule
Task 4 – Develop convection-ATM-specific improvements to guidance from the HRRR (and later, HRRRE) and interact with CoSPA (or other) program partner labs and the FAA	
Complete implementation of new microphysics for associated reflectivity echo-top diagnostics for 2013 real-time use (ESRL) • Code for revised echo-top / reflectivity diagnostics with revised microphysics implemented in GSD real-time HRRR.	Mar 2013 **COMPLETE**
Conduct baseline testing of the early 2013 HRRR version (ESRL) • Baseline testing of 2013 HRRR version completed as part of code preparation for freeze. Summary of skill score improvements being prepared.	Mar 2013 **COMPLETE**
Report on evaluation of new microphysics scheme and associated echo-top and reflectivity diagnostics in ESRL/GSD RAP and HRRR (ESRL) • *Preliminary evaluation completed and summarized in report:* **http://ruc.noaa.gov/pdf/GSD_reflectivity_report.pdf**	Mar 2013 **COMPLETE**
Assess HRRR reliability and provide monthly reporting (ESRL) Reliability statistics are being reported each month	*Apr 2013* **COMPLETE** *(ongoing)*
Report on evaluation of revised WRFv3.4 microphysics for RAP/HRRR for its effects on echo-top and reflectivity in ESRL RAP/HRRR (ESRL)	Mar 2014
Complete implementation of new microphysics for associated reflectivity echo-top diagnostics for 2014 real-time use of HRRR (ESRL)	Mar 2014
Complete implementation of refined SatCast assimilation for HRRR for real-time use in 2014 (ESRL) **Evaluation of preliminary results**	Mar 2014 **Good progress**
Report on 2014 baseline testing of the HRRR (ESRL)	Mar 2014